AMIMON WHDI™
High-Definition Wireless

How WHDI enables true uncompressed wireless video today

The transformation set to standardize wireless video communications

Marketing Technology Overview

September 2018

Contents

Executive Summary

Wireless connectivity has impacted consumer's lifestyle by introducing mobility and convenience. With the imminent proliferation of HD devices, consumers are demanding the same convenience in the digital home. But the solutions to date are unable to support the transmission rates for real time HD content. A new technology is needed to enable wireless HD connectivity without compressing and without compromising video transmission.

The transformation to high definition content has created consumer demand for high quality digital video connectivity between HDTVs (High Definition Television) and other Consumer Electronic (CE) devices. From projectors and plasmas to DVDs and gaming - there is a whole generation of new CE devices about to pay homage to the HD era.

HDMI (High Definition Multimedia Interface), the enabling digital interface for HD and consumer electronics, is on the verge of becoming a ubiquitous audio visual interface. Already today HDMI connectors are embedded in CE devices. HDMI device sales are forecasted to grow from XX units in 2006 to ..? units in 2008. But the convenience and benefits of an increasingly digital home, free of complex cables, cannot be realized without a true wireless technology that delivers low-cost uncompressed HDTV, at the quality of HDMI connectivity.

WHDI™ is the only successful solution to deliver a wireless HD interface that provides uncompressed A/V streaming and high speed content transmission on a consumer-friendly frequency band, at wire equivalent quality.

This paper will outline how Amimon's WHDI™ already today enables true uncompressed wireless A/V connectivity and why WHDI is poised to become the new wireless video communications industry standard.

It will focus on the two key technical enablers of Amimon's WHDI™ technology; **JSCC -** Joint Source Channel Coding – a video aware modem solution and Amimon's unique adaptation of **MIMO** – Multiple Input Multiple Output Antenna Communication.

Background

Uncompressed, as opposed to compressed video connectivity is fully supported by the media and movie production houses as it's the only solution to protect the industry from piracy and copyright infringement. But transmitting uncompressed HD video seamlessly and wirelessly requires a large amount of radio bandwidth and a consumer / technology frequency band - a technical challenge to speed, quality and the very nature of data transmission that till recently was considered impossible. Here's why:

Speed - Next generation high definition consumer electronics demand connectivity speeds up to 3Gbps and beyond to support HD applications high resolution rates. The new rates present a huge challenge to any interfacing technology: 720p HDTV at 8-bits per color pixel, requires 1.3Gbps, while next level 1080i HDTV requires 1.5Gbps. The more progressive 1080p format, set to become the de-facto gold standard for HD devices requires 3Gbps. To date, no wireless modem technology can reliably meet these challenging rates for A/V transmission. Emerging wireless communication technologies such as Ultra Wide Band and 802.11n are even struggling to support lower video rates without sacrificing quality, latency and copyright protection.

Quality - Another challenge is the fading multi-path behavior of indoor wireless channels; even with sufficient bandwidth over a period of time, the signal tends to fade in and out in emerging wireless A/V technologies.

A/V vs. data transmission - A/V communication is synchronous, works in real time and does not tolerate delay. Other wireless technologies are based on data transmission modems and are asynchronous in nature. They have not been designed to work in real time with the continuous QoS (Quality of Service) needed for A/V.

Physical communication - despite all efforts to standardize A/V communication, current data transmission technologies don't target the physical communication layer. The price of avoidance - restricted transmission at rates needed for HDTV.

Frequency band – At 2.4 to 5GHz there is no bandwidth for HDTV the unlicensed available 60 GHz band specified for potential wireless HD suffers from extra path loss and does not tolerate any blockage infant technology. Any form of technical compensation for these shortcomings comes with a hefty price. I would like to clarify the above comment with you.

The challenge for high performance wireless A/V connectivity calls for another solution – one that delivers low cost, high speed uncompressed transmission without compromising quality, latency and error protection.

How WHDI enables uncompressed wireless video today

A case for Joint Source Channel Coding (JSCC):

In video transmission performance is key. To this end traditional A/V technologies focused on delivering video streaming by separating the source and channel coding **- See Figure 1.** The separation process optimizes source and channel coders and creates interoperability through a digital interface.

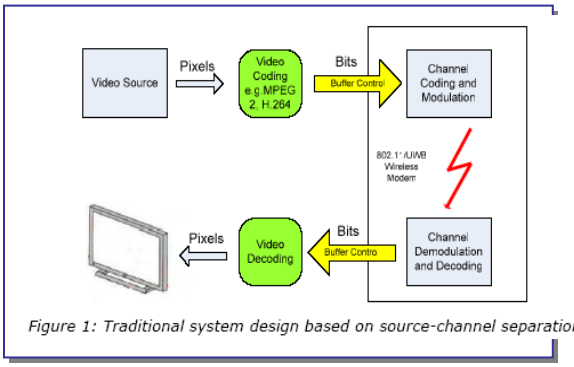

Figure 1: Traditional system design based on source-channel separation

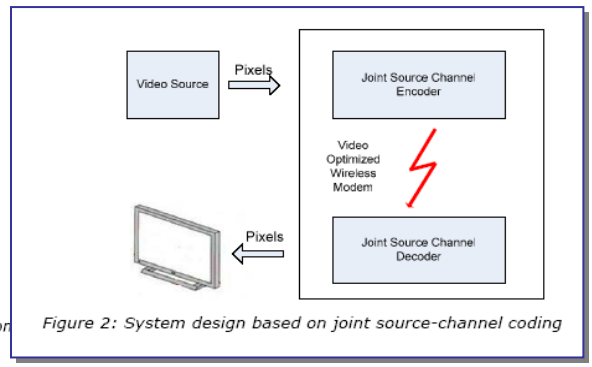

Figure 2: System design based on joint source-channel coding

In wireless video transmission separation is no longer applicable; firstly because the separation theory assumes known channel capacity, yet capacity in wireless video is unpredictable, secondly separation can be unreliable - the source code (compression) is too sensitive, finally separation is a complex process that produces large delays in wireless transmission**.**

Amimon's JSCC (Joint Source Channel Coding) technology:

WHDI overcomes these challenges through JSCC– a video aware modem solution **- see figure 2**. This key technical enabler operates on three principles:

- Prioritization – arranges video components by level of importance
- Unequal Error Protection (UEP) – encodes significant parts of high priority components vs. least significant parts of low priority components
- Joint UEP and modulation – produces the correct constellation in the channel signal space by translating video pixels at an ultra low latency level, to orthogonal frequency division modulation (OFDM) symbols. The OFDM signal's total bandwidth becomes proportional to the video pixel rate **- see figure 3.**

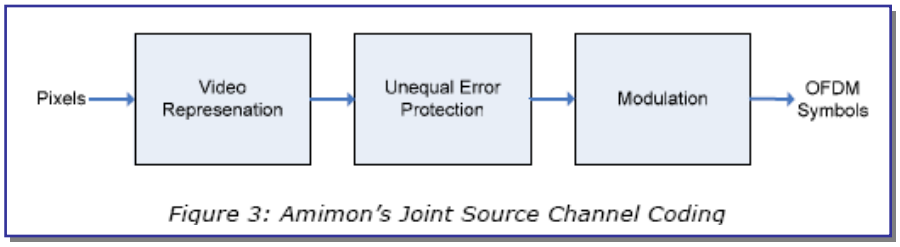

Figure 3: Amimon's Joint Source Channel Coding

JSCC advantages over emerging technologies:

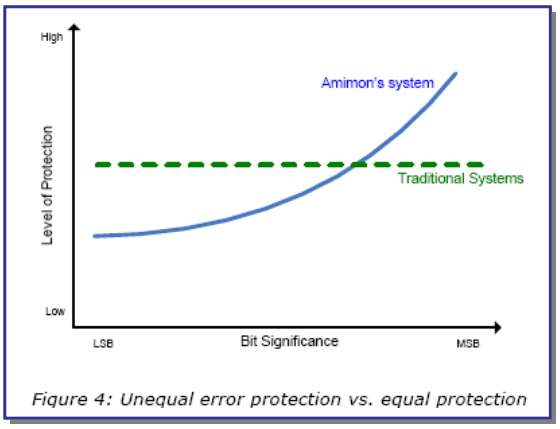

Figure 4: Unequal error protection vs. equal protection

JSCC optimizes capacity through UEP while other wireless technologies evenly distribute protection across all parts causing a lot of wastage **- see figure 4**. Optimization is further achieved by seamlessly adapting to varying channel capacities. Other technologies operate at one rate below the lowest channel capacity. Some technologies manage to adapt to varying rates by using feedback or buffers, but both cause complications and delays **- See figure 5**.

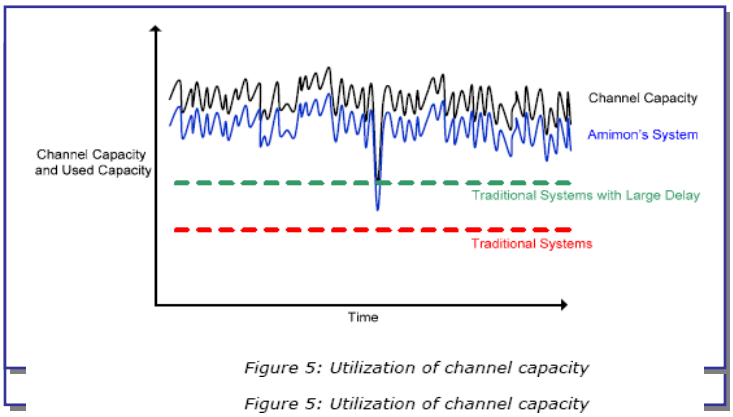

Figure 5: Utilization of channel capacity

Figure 5: Utilization of channel capacity

One of JSCC's main advantages is its seamless adaptation to the channel Signal to Noise Ratio (SNR). Other technologies are compromised by a reduced threshold effect - they must work on a minimal SNR level to prevent communication breakdown. Unfortunately the trade-off is deeper compression. Even with enhanced channel quality, they are restricted by a "quality ceiling" whereas JSCC has no SNR or quality constraint **– see figure 6.**

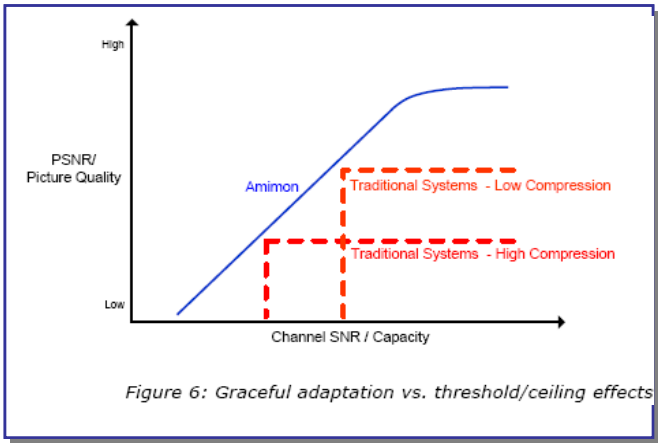

Figure 6: Graceful adaptation vs. threshold/ceiling effects

Multiple Input - Multiple Output (MIMO) and the wireless indoor channel:

MIMO has emerged as a key factor for boosting wireless communication: It is a successful multiplexing technique for enhancing bandwidth, range and spectral efficiency by increasing capacity and robustness. To extend MIMO's success to wireless A/V a new solution is needed – one that will deliver more reliability while providing enough freedom. **See figure 7 for a MIMO diagram**

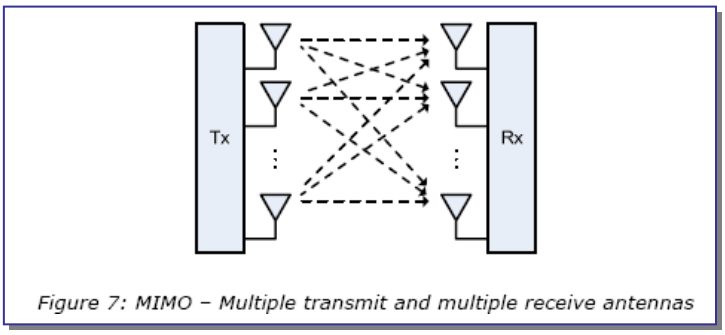

Figure 7: MIMO – Multiple transmit and multiple receive antennas

Amimon chose to work on the consumer friendly unlicensed 5GHz frequency band where there is more free space and greater opportunities. But a new approach is needed to overcome signal and fading challenges and to provide synchronous low latency transfer at the rates of uncompressed HDTV.
We do not need to explain in this paper how MIMO works, only Amimon's special MIMO features like 4x5 …Amimon's adaptation of MIMO easily overcomes these challenges: WHDI's progression from MIMO's two-way transmission to a four by five multiple transmission has significantly enhanced diversity and boosted bandwidth efficiency.

MIMO's triumphs encouraged research into Space Time Coding (STC) – a technique that dramatically enhances MIMO capacities. STC in conjunction with MIMO achieves increased channel dimensionality with dramatically more link reliability. WHDI has captured the advantages of STC with MIMO to gain increased capacity, while maintaining enough multiplexing for HDTV rates.

WHDI Wireless A/V Highlights

- Wireless A/V with latency under 1ms - at wire equivalent quality
- Transmission in the consumer and technology friendly 5GHz frequency band
- Scalable - supports current and future video resolutions from 720p to 1080i, 1080p and beyond
- Uncompressed transmission, ensures protection of copyrighted content and industry support
- WHDI JSCC technology - significant breakthrough in coding and memory
- Heightened error protection through advanced error correction technique
- Point to multi-point architecture - no communication and quality compromises
- WHDI's upgraded version of MIMO significantly increases reliability
- Boosted capacity through innovative adaptation of STC with MIMO

WHDI Wireless A/V Applications

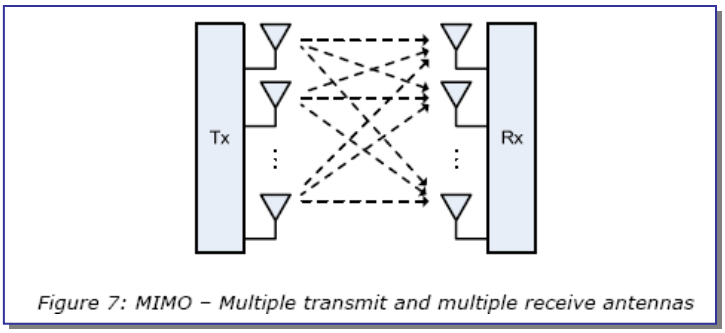

Figure 7: MIMO – Multiple transmit and multiple receive antennas

Amimon chose to work on the consumer friendly 5GHz frequency band where there is more free space and greater opportunities. But a new approach is needed due to signal and fading challenges and a need for synchronous low latency transfer at the rates of uncompressed HDTV.
MIMO easily overcomes these challenges through enhanced diversity and increased bandwidth efficiency. In MIMO there are N_t transmit antennas and N_r receive antennas where N_r is greater or equal to N_t. Although the signals interfere with each other, the receiver can cancel interference and construct the N_t inputs. MIMO enables availability of many paths, a feature responsible for reducing the severe effects of fading paths on freedom. When diversity is needed, redundant information is sent through the transmit antennas to provide extra path diversity for transmitted information.

MIMO's triumphs encouraged research into Space Time Coding (STC) – a technique that dramatically enhances MIMO capacities. STC in conjunction with MIMO achieves increased channel dimensionality with dramatically more link

reliability. WHDI has captured the advantages of STC with MIMO to gain boosted capacity, while maintaining enough multiplexing for HDTV rates.

WHDI Wireless A/V Highlights

- Wireless A/V with latency under 1ms - at wire equivalent quality
- Transmission in the consumer and technology friendly 5GHz frequency band
- Scalable - supports current and future video resolutions from 720p to 1080i
- Protection of copyrighted content by removing compression
- WHDI JSCC technology - significant breakthrough in coding and memory
- Heightened error protection through advanced error correction technique
- Point to multi-point architecture - no communication and quality compromises
- WHDI's upgraded version of MIMO significantly increases reliability
- Boosted capacity through innovative adaptation of STC with MIMO

Summary

True uncompressed wireless HDTV with uncompromised quality and reliability demands an entirely new approach to the data-centric modem system. Amimon's video-aware modem approach makes use of expertise in Joint Source Channel Coding to solve the challenges of varying wireless conditions. Uncompressed wireless A/V also requires optimum wireless link reliability while providing enough freedom. This crucial aspect is achieved by enhancing MIMO with new multiple transmission developments and STC. With these two key enablers Amimon successfully delivers uncompressed wireless HDTV at an HDMI quality.

WHDI's breakthrough in wireless video pledges a heightened user experience, introducing the realities of a digital home already today. Overcoming all the challenges of true wireless A/V, WHDI is well positioned to become the new wireless video communications industry standard.

By Debbie Meltzer